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CURRICULUM VITAE

EDUCATION:

2011 **Ph.D.**, Astrophysical and Planetary Sciences, University of Colorado at Boulder
Dissertation entitled: *Galaxy Cluster Scaling Relations with APEX-SZ*. Advisor: Prof. Nils Halverson

2006 **M.S.**, Astrophysical, Planetary and Atmospheric Sciences
University of Colorado at Boulder

2004 **B.S.**, Physics
University of Illinois at Urbana-Champaign

RESEARCH EXPERIENCE

2016 - present **Assistant Physicist**
Argonne National Laboratory
Instrumentation & Operations for South Pole Telescope 3rd Generation Receiver

- Optimization of readout electronics in the SPT-3G receiver
- Routine monitoring of data quality and receiver performance

Development of Frequency Domain Multiplexing (fMux) Readout Technology

- Development of new cryogenic architecture for fMux system for operation of low resistance ($r < 0.5\,\Omega$) transition-edge sensor bolometers

2014 - 2016 **Postdoctoral Researcher**
Argonne National Laboratory with Clarence Chang
Associate Fellow, Kavli Institute for Cosmological Physics, University of Chicago

Instrumentation for South Pole Telescope 3rd Generation Receiver (SPT-3G)
SPT-3G will contain 16,000 polarization-sensitive transition-edge sensor (TES) bolometers to make multi-wavelength measurements of the Cosmic Microwave Background (CMB) polarization.

- Systematics optimized design of cryogenic readout electronics for SPT-3G.
- Integration and characterization of cryogenic readout components for SPT-3G, including Superconducting Quantum Interference Devices (SQUIDs) and superconducting resonator neworks.
- Integration of readout electronics with SPT-3G detectors for both detector and full system characterization.
- Characterization of superconducting material samples for SPT-3G detectors.
- Coordination of unified detector and readout characterization effort across eight universities/laboratories.

Galaxy Cluster Analysis with South Pole Telescope Data

- Using existing SPT CMB survey data to measure the pressure profile of galaxy clusters.

2011 - 2014 **Postdoctoral Fellow in Astrophysics**
McGill University with Matthew Dobbs

Readout Electronics Development for CMB Telescopes

- Laboratory commissioning of readout electronics for large-format TES bolometer arrays to be deployed on the South Pole Telescope and POLARBEAR2 experiment.
- Characterized instrumental systematics for SPT polarization (SPTpol) receiver.

Millimeter-Wavelength Galaxy Cluster Measurements

- Continued ongoing analysis with Atacama Pathfinder Experiment SZ-receiver (APEX-SZ) data to correlate millimeter and X-ray observations of galaxy clusters.

2007 - 2011 **Graduate Research Assistant**
University of Colorado at Boulder with Nils Halverson

- Deployment and overall characterization of the millimeter-wavelength APEX-SZ experiment, designed to measure secondary anisotropies in the CMB.
- Analyzed observations from APEX-SZ to measure millimeter-wavelength flux from galaxy clusters and correlate with X-ray cluster properties.

2005 - 2007 **Graduate Research Assistant**
University of Colorado at Boulder with Erica Ellingson Analyzed Hubble Space Telescope Advanced Camera for Surveys data to investigate the influence of the galaxy cluster environment on galaxy evolution

2002 - 2004 **Undergraduate Research Assistant**
University of Illinois at Urbana-Champaign with Robert Brunner Compared intrinsic properties of Sloan Digital Sky Survey quasars with statistical excesses in the number of galaxies in their local environments.

2003 **Undergraduate Research Assistant**
Kitt Peak National Observatory REU with Richard Green Analyzed optical spectra to determine the velocity dispersion of the stars surrounding and the mass of the supermassive black hole in NGC 4486B

2002 **Undergraduate Research Assistant**
University of Chicago REU with Donald York Created a catalogue of quasar - galaxy near neighbors from the Sloan Digital Sky Survey used to map the gaseous galactic halo.

REFERENCES:

Prof. Clarence L. Chang, Argonne National Laboratory/University of Chicago, clchang@kicp.uchicago.edu

Prof. Matthew A. Dobbs, McGill University, matt.dobbs@mcgill.ca

Prof. John Carlstrom, University of Chicago, jc@kicp.uchicago.edu

Prof. William Holzapfel, University of California at Berkeley, swlh@cosmology.berkeley.edu

Prof. Nils W. Halverson, University of Colorado at Boulder, nils.halverson@colorado.edu

REFEREED PUBLICATIONS:

Raghunathan, S. , ... **Bender, A.N.**, ... et al., 2018, "Mass Calibration of Optically Selected DES clusters using a Measurement of CMB-Cluster Lensing with SPTpol Data", *submitted to the Astrophysical Journal*

Carter, F.W., ... **Bender, A.N.**, ... et al., 2018, "Tuning SPT-3G Transition-Edge-Sensor Electrical Properties with a Four-Layer Ti-Au-Ti-Au Thin-Film Stack ", *Journal of Low Temperature Physics*

Posada, C.M., ... **Bender, A.N.**, ... et al., 2018, "Fabrication of Detector Arrays for the SPT-3G Receiver ", *Journal of Low Temperature Physics*

Pan, Z., ... **Bender, A.N.**, ... et al., 2018, "Optical Characterization of the SPT-3G Camera ", *Journal of Low Temperature Physics*

Avva, J.S., ... **Bender, A.N.**, ... et al., 2018, "Design and Assembly of SPT-3G Cold Readout Hardware", *Journal of Low Temperature Physics*

Ding, J., ... **Bender, A.N.**, ... et al., 2018, " Thermal Links and Microstrip Transmission Lines in SPT-3G Bolometers", *Journal of Low Temperature Physics*

Anderson, A.J., ... **Bender, A.N.**, ... et al., 2018, "SPT-3G: A Multichroic Receiver for the South Pole Telescope ", *Journal of Low Temperature Physics*

Nagarajan, A., ... **Bender, A.N.**, ... et al.,2018, "Weak-lensing mass calibration of the Sunyaev-Zel'dovich effect using APEX-SZ galaxy clusters", *Monthly Notices of the Royal Astronomical Society,* sty1904

Henning, J.W., ... **Bender, A.N.**, ... et al., 2018, "Measurements of the Temperature and E-Mode Polarization of the CMB from 500 Square Degrees of SPTpol Data", *Astrophysical Journal*, 852,97

Manzotti, A., ... **Bender, A.N.**, ... et al., 2017, "CMB Polarization B-mode Delensing with SPTpol and Herschel", *Astrophysical Journal*, 846, 45

Bandura, K., **Bender, A.N.**, ... et al., 2016, "ICE: a scalable, low-cost FPGA-based telescope signal processing and networking system", *Journal of Astronomical Instrumentation* , 5, 1641005

Bender, A.N., Kennedy, J. et al., 2016, "Galaxy cluster scaling relations measured with APEX-SZ", *Monthly Notices of the Royal Astronomical Society*, 460, 3432

Whitehorn, N., Natoli, T., ... **Bender, A.N.**,... et al., 2016, "Millimeter Transient Point Sources in the SPTpol 100 Square Degree Survey", *Astrophysical Journal*, 830, 143

Posada, C., ... **Bender, A.N.**, ... et al., 2015, '"Fabrication of large dual-polarized multichroic TES bolometer arrays for CMB measurements with the SPT-3G camera", *Superconducting Science and Technology*, 28, 094002

Story, K.T., Hanson, D., ... **Bender, A.N.**, ... et al., 2015, "A Measurement of the Cosmic Microwave Background Gravitational Lensing Potential from 100 Square Degrees of SPTpol Data", *ApJ*, 810, 50

Keisler, R., Hoover, S., Harrington, N., ... **Bender, A.N.**, ... et al., 2015, "Measurements of Sub-Degree B-Mode Polarization in the Cosmic Microwave Background from 100 Square Degrees of SPTpol Data", *The Astrophysical Journal*, 807, 15

Crites, A.T., Henning, J.W., ... **Bender, A.N.**, ... et al., 2015, "Measurements of the E-mode Polarization and Temperature-E-Mode Correlation in the Cosmic Microwave Background from 100 Square Degrees of SPTpol Data", *The Astrophysical Journal*, 805, 36

Hanson, D., Hoover, S., Crites, A., ... **Bender, A.N.**, ... et al., "Detection of B-Mode Polarization in the Cosmic Microwave Background with Data from the South Pole Telescope", *Physical Review Letters*, 111,141301

Dobbs, M.A., Lueker, M., ... **Bender, A.N.**, ... et al., 2012, "Frequency multiplexed superconducting quantum interference device readout of large bolometer arrays for cosmic microwave background measurements", *Review of Scientific Instruments*, 83, 073113

Schwan, D., Ade, P.A.R., Basu, K., **Bender, A.N.** et al., 2011, "The APEX-SZ Instrument", *Review of Scientific Instruments*, 82, 091301

Basu, K., Zhang, Y.-Y., Sommer, M.W., **Bender, A.N**. et al., 2010, "Non-parametric modeling of the intracluster gas using APEX-SZ bolometer imaging data", *Astronomy & Astrophysics*, 519, 29

Nord, M., Basu, K., Pacaud, F., Ade, P.A.R., **Bender, A.N.** et al., 2009, "Multi-frequency imaging of the galaxy cluster Abell 2163 using the Sunyaev-Zel'dovich Effect", *Astronomy & Astrophysics*, 506, 623

Reichardt, C.L., Zahn, O., Ade, P.A.R., Basu, K., **Bender, A.N.** et al., 2009, "Constraints on the High-ℓ Power Spectrum of Millimeter-wave Anisotropies from APEX-SZ",*The Astrophysical Journal*, 701, 1958

Halverson, N.W., Lanting, T., Ade, P.A.R., Basu, K., **Bender, A.N.** et al., 2009, "Sunyaev-Zel'dovich Effect Observations of the Bullet Cluster (1E 0657-56) with APEX-SZ", *The Astrophysical Journal*, 701, 42

NON-REFEREED PUBLICATIONS

Bender, A.N., et al., 2018, "Year two instrument status of the SPT-3G cosmic microwave background receiver", *Proceedings of the SPIE*,10708, 1070803

Lowitz, A. E., **Bender, A.N.**,Dobbs, M.A., Gilbert, A.J., 2018, "Digital frequency multiplexing with sub-Kelvin SQUIDs", *Proceedings of the SPIE*,10708, 107081D

Harke-Hosemann, A., **Bender, A. N.**, Chang, C. L., Polakovic, T., Novosad, V., 2018, "Investigation of magnetic shielding for superconducting readout", *Proceedings of the SPIE*,10708, 1070846

Dutcher, D., ... **Bender, A.N.**, ... et al., 2018, "Characterization and performance of the second-year SPT-3G focal plane", *Proceedings of the SPIE*,10708, 107081Z

Nadolski, A. ... **Bender, A.N.**, ... et al., 2018, "Broadband anti-reflective coatings for cosmic microwave background experiments", *Proceedings of the SPIE*,10708,1070843

Sobrin, J., ... **Bender, A.N.**, ... et al., 2018, "Design and characterization of the SPT-3G receiver", *Proceedings of the SPIE*,10708, 107081H

"CMB-S4 Technology Book, First Edition", 2017,arXiv:1706.02464

Bender, A.N., et al., 2016, "Integrated Performance of a Frequency Domain Multiplexing Readout in the SPT-3G Receiver", *Proceedings of the SPIE*, 9914, 99141D

Posada, C., ... **Bender, A.N.**, ... et al., 2016, "Large arrays of dual-polarized multichroic TES detectors for CMB measurements with the SPT-3G receiver", *Proceedings of the SPIE*, 9914, 991417

Stebor, N., ... **Bender, A.N.**, ... et al., 2016, "The Simons Array CMB polarization experiment", *Proceedings of the SPIE*, 9914, 99141H

Suzuki, A., ... **Bender, A.N.**, ... et al., 2016,"The POLARBEAR-2 and the Simons Array Experiment", *Journal of Low Temperature Physics*, 184, 805

Hattori, K., ... **Bender, A.N.**, ... et al., 2016, "Development of readout electronics for POLARBEAR-2 Cosmic Microwave Background experiment", *Journal of Low Temperature Physics*, 184, 512

Bender, A.N, et al., 2014, "Digital frequency domain multiplexing readout electronics for the next generation of millimeter telescopes", *Proceedings of the SPIE*, 9153, 91531A

Benson, B.A., . . . **Bender, A.N.**, . . . et al., 2014, "SPT-3G: A Next-Generation Cosmic Microwave Background Polarization Experiment on the South Pole Telescope", *Proceedings of the SPIE*, 9153, 91531P

Hattori, K., . . . **Bender, A.N.**, . . . et al., 2014, "Optimization of cold resonant filters for frequency domain multiplexed readout of POLARBEAR-2",*Proceedings of the SPIE*, 9153, 91531B

Barron, D., . . . **Bender, A.N.**, . . . et al., 2014, "Developement and characterization of the readout system for POLARBEAR-2", *Proceedings of the SPIE*, 9153, 915335

Arnold, K., . . . **Bender, A.N.**, . . . et al., 2014, "The Simons Array: expanding POLARBEAR to three multichroic telescopes", *Proceedings of the SPIE*, 9153, 91531F

Inoue, Y., . . . **Bender, A.N.**, . . . et al., 2014, "Thermal and optical characterization for POLARBEAR-2 optical system", *Proceedings of the SPIE*, 9153, 91533A

George, E.M., . . . **Bender, A.N.**, . . . et al., 2012, "Performance and on-sky characterization of the SPTpol instrument", *Proceedings of the SPIE*, 8452

Austermann, J.E., . . . **Bender, A.N.**, . . . et al., 2012, " SPTpol: an instrument for CMB polarization measurements with the South Pole Telescope", *Proceedings of the SPIE*, 8452

Story, K., Leitch, E., . . . **Bender, A.N.**, . . . et al., 2012, "South Pole Telescope software systems: control, monitoring , and data acquisition", *Proceedings of the SPIE*, 8452

Bender, A.N. "Galaxy Cluster Scaling Relations with APEX-SZ", Ph.D. thesis, 2011

Mehl, J., Ade, P.A.R., Basu, K., Becker, D., **Bender, A.** et al., 2008, "TES Bolometer Array for the APEX-SZ Camera", *Journal of Low Temperature Physics*, 151, 697

"The Evolution of Galaxy Populations in Clusters Along the Road to Coma", poster, International Astronomical Union General Assembly, 2006

"The Massive Black Hole in the Dwarf Galaxy NGC 4486B", poster, American Astronomical Society Meeting 203, 2004

"Quantifying the Local Environment of Low Redshift Quasars", poster, American Astronomical Society Meeting 203, 2004

TALKS & PRESENTATIONS

Nov 2018	**Invited Talk**: "Multiplexed readout of TES bolometers for the South Pole Telescope", Applied Superconductivity Conference
June 2018	**Invited Talk**: "CMB with the South Pole Telescope (SPT-3G and SPTpol) and planning for 'Stage 4' (S4)", Fermilab Users Meeting
June 2018	"Year 2 instrument status from the SPT-3G cosmic microwave background receiver", International Society for Optics and Photonics Astronomical Telescopes and Instrumentation Meeting
Mar 2018	"Year 2 Update from the SPT-3G Cosmic Microwave Background Experiment", Recontres de Moriond, Cosmology Session
July 2017	**Invited Talk**, "Recent Progress from the SPT-3G Experiment",Meeting of the Division of Particles and Fields of the American Physical Society
May 2017	**Invited Talk**: "Cosmic Microwave Background Measurements with the South Pole Telescope", Recontres de Blois

April 2017	**Invited Talk**: "The South Pole Telescope: Searching for cosmological answers with the CMB", University of Iowa, Physics Colloquium
March 2017	**Invited Talk**: "The South Pole Telescope: Searching for cosmological answers with the CMB", Northwestern University, Astrophysics Seminar
Aug. 2016	"Superconducting Detector Development for the SPT-3G Cosmic Microwave Background Experiment", poster presentation at the 38th International Conference on High Energy Physics
July 2016	"Integrated Performance of a Frequency Domain Multiplexing Readout in the SPT-3G Receiver", International Society for Optics and Photonics Astronomical Telescopes and Instrumentation Meeting
June 2016	**Invited Talk**:"Building a Next-Generation Cosmic Microwave Background Experiment", Argonne National Laboratory, High Energy Physics Seminar
March 2016	"Measurements of the Cosmic Microwave Background Polarization with the South Pole Telescope Polarization Receiver (SPTpol)", Recontres de Moriond, Cosmology Session
Jan. 2016	**Invited Talk**:"Advances in Millimeter-Wavelength Instrumentation with the South Pole Telescope", Fermi National Accelerator Laboratory, Particle Astrophysics Seminar
Aug. 2015	"SPT-3G: The Next Generation Receiver for Polarized Cosmic Microwave Background Measurements with the South Pole Telescope", Meeting of the Division of Particles and Fields of the American Physical Society
July 2015	"SPT-3G: The Next Generation Receiver for the South Pole Telescope", 16th International Workshop on Low Temperature Detectors
March 2015	"SPT-3G Readout Electronics: Design and Commissioning", Kavli Institute for Cosmological Physics Postdoctoral Winter Symposium
June 2014	"Digital Frequency Domain Multiplexing Readout Electronics for the Next Generation of Millimeter Telescopes", International Society for Optics and Photonics Astronomical Telescopes and Instrumentation Meeting
Feb. 2014	**Invited Talk**: "Advances in Cosmology and Millimeter-Wavelength Instrumentation with the South Pole Telescope", Argonne National Laboratory High Energy Physics Division Seminar
May 2013	**Invited Talk**: "Measurements of the CMB Polarization with the South Pole Telescope", Congress of the Canadian Association of Physicists
Jan. 2011	**Invited Talk:** "Sunyaev-Zel'dovich Scaling Relations with APEX-SZ", McGill University astrophysics seminar
Jan. 2011	"Measuring Sunyaev-Zel'dovich Scaling Relations with APEX-SZ", Winter meeting of the American Astronomical Society
Mar. 2010	"Recent Results with APEX-SZ", SnowPAC Conference, Utah
July 2009	"APEX-SZ Data Analysis Techniques", Sunyaev-Zel'dovich Clusters workshop, Bonn, Germany
May 2009	"Measuring Sunyaev-Zel'dovich Scaling Relations with APEX-SZ", American Physical Society April Meeting

GRANTS & FUNDING:

2019	Argonne National Laboratory Lab Directed Research & Development Program: "Novel Methods for 3-D Integration of Superconducting Detectors and Readout", $225,000

HONORS & AWARDS:

2017	Physical Sciences and Engineering Excellence Award Argonne National Laboratory
2011 - 2014	Astronomy and Astrophysics Postdoctoral Fellowship Dept. of Physics, McGill University
2007	Chance Irick Cooke Graduate Fellowship Dept. of Astrophysics and Planetary Sciences, University of Colorado at Boulder
2007	Departmental Teaching Assistant Award Dept. of Astrophysics and Planetary Sciences, University of Colorado at Boulder
2006	Parmenter Graduate Fellowship Dept. of Astrophysics and Planetary Sciences, University of Colorado at Boulder
2005	Returning Graduate Student Supplemental Fellowship Dept. of Astrophysics and Planetary Science, University of Colorado at Boulder
2004	Phi Beta Kappa University of Illinois at Urbana-Champaign
2004	Laura B. Eisenstein Award Dept. of Physics, University of Illinois at Urbana-Champaign
2004	Stanley P. Wyatt Memorial Award Dept. of Astronomy, University of Illinois at Urbana-Champaign

STUDENT MENTORING:

2018 - present	Co-mentor for University of Chicago graduate student John Hood
2017 - 2018	Supervisor for Argonne National Laboratory research assistant Angelina Harke-Hosemann
2015 - 2017	Supervisor for University of Chicago/ Argonne National Laboratory undergraduate research assistant Lauren Saunders
2014 - 2017	Supervisor for University of Chicago undergraduate Anthony Corso
2014	University of Chicago, Co-mentor of M.S. student Gabrielle Cole
2011 - 2014	McGill University, Co-mentor for Ph.D. student Joshua Montgomery and undergraduate Amy Tang

OUTREACH AND SERVICE ACTIVITIES:

2018	Delegate at Early Career Focus Session for the Astro2020 Decadal Survey on Astronomy and Astrophysics
2018	Member of governing board for CMB-S4 collaboration
2018	Local organizing committee and organizer of parallel session on readout technology at CMB-S4 workshop at Argonne National Laboratory
2017	Kavli Roundtable on "Astrophysics at the Ends of the Earth"

2016	Session convener for CPAD Instrumentation Frontier Meeting
2016	Co-creator of Young Scientist Symposium for Argonne High Energy Physics Division
2015 - current	Adler Planetarium Astronomy Conversations Program Presenter
2013	"The South Pole Telescope: Observing the Infant Universe from the End of the World" Public lecture for Astro McGill Public Astronomy Night
2012 - 2014	Astro McGill Public Outreach Group Activities include hosting monthly public lectures followed by observing and lab tours, primary school visits, and hosting special events such as the Quebec-wide "24 hours of Science".
2012 - 2014	Women in Physics Committee at McGill
2004 - 2011	Volunteer host for Friday night public open house at Sommers-Bausch Observatory Volunteer host for Astronomy Day University of Colorado at Boulder
2004 - 2011	Student Representative on Departmental Committees Dept. of Astrophysics and Planetary Sciences, University of Colorado at Boulder *2005:* Graduate Admissions *2006:* Graduate Admissions, Graduate Exams *2007:* Student Representative to Faculty Meetings *2008:* Student Representative to Faculty Meetings

TEACHING EXPERIENCE:

2017	**CMB Detectors and Instrumentation**, Instructor for summer school, Kavli Institute for Cosmological Physics
2012	**Galaxies & Cosmology: The CMB** Co-Instructor for graduate course, Dept. of Physics, McGill University
2004 - 2007	Teaching Assistant Dept. of Astrophysics and Planetary Sciences, University of Colorado at Boulder
	2006, 2007: **Observations and Instrumentation 1** Laboratory section instructor for upper level astronomy course.
	2004, 2005: **Introductory Astronomy** Laboratory section instructor.
	2007: Grading Assistant